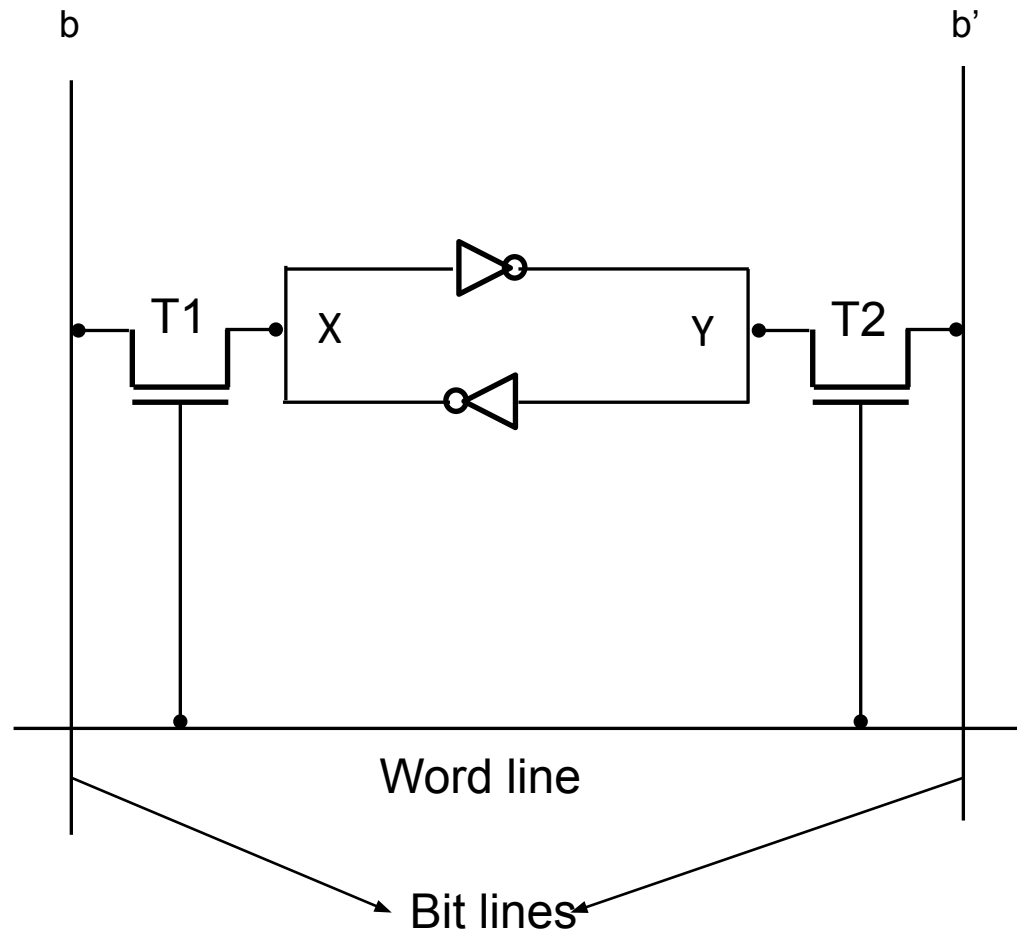


A static RAM cell



A static RAM cell

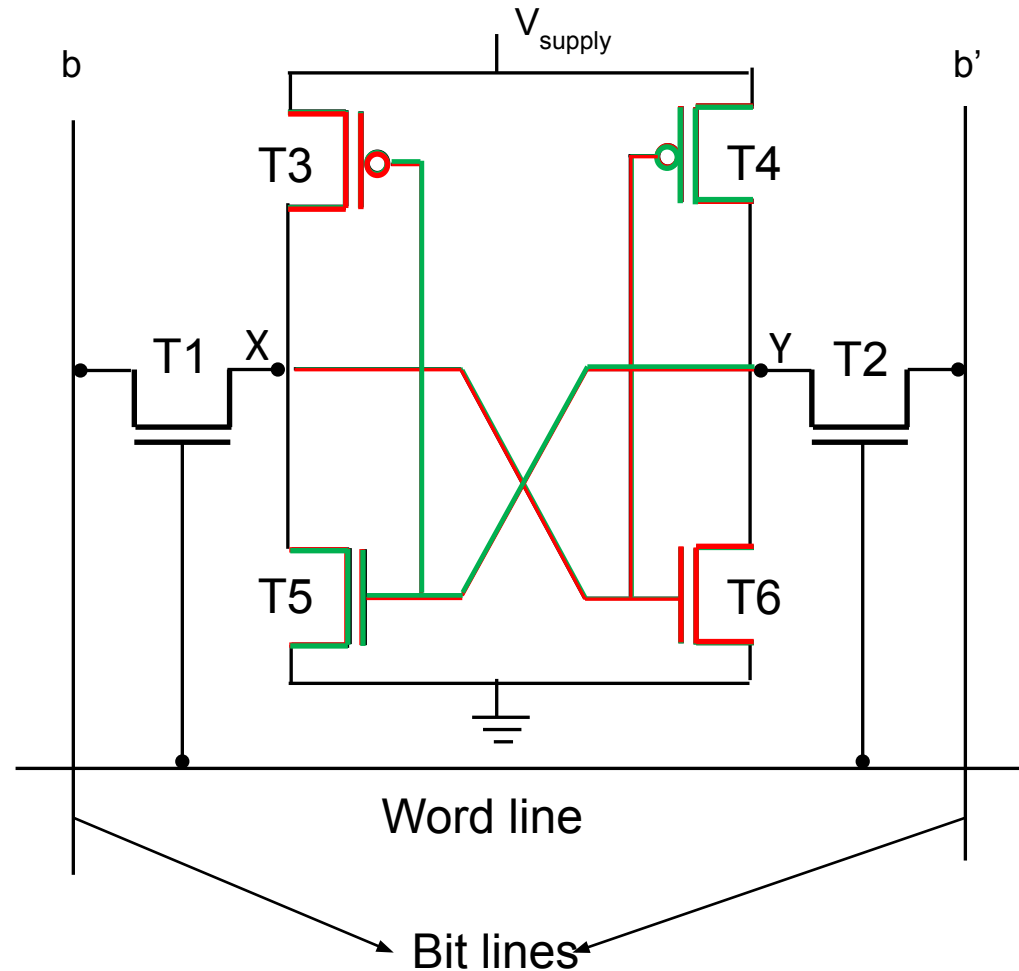
Read Operation

- The word line is activated to on switches $T1$ and $T2$.
- If the cell is in state 1, the signal on bit line b is high and the signal on bit line b' is low.
- The opposite is true if the cell is in state 0.
- Thus, b and b' are always complements of each other.
- The Sense circuit at the end of the two bit lines monitors their state and sets the corresponding output accordingly.

Write Operation

- The Sense/Write circuit drives bit lines b and b' , instead of sensing their state.
- It places the appropriate value on bit line b and its complement on b' .
- activates the word line.
- when the word line is deactivated it is maintained its state whatever is written into the cell.

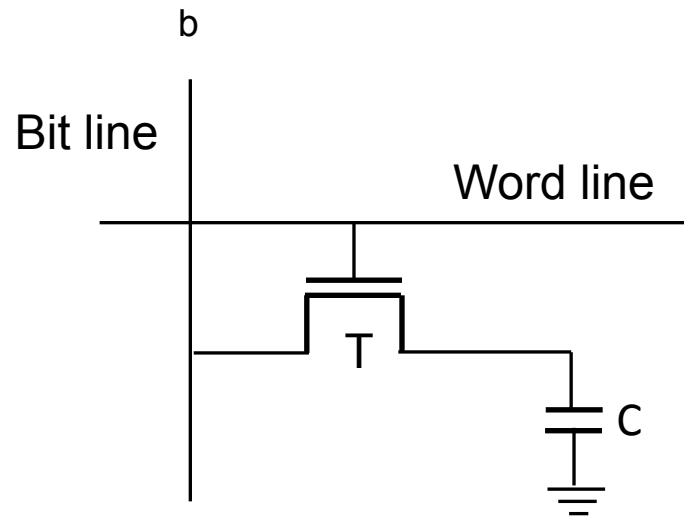
An example of a CMOS memory cell.



CMOS SRAM Cell

- In state 1, the voltage at point X is maintained high by having transistors T3 and T6 on, while T4 and T5 are off.
- If T1 and T2 are turned on, bit lines b and b' will have high and low signals, respectively.
- Continuous power is needed for the cell to retain its state.
- If power is interrupted, the cell's contents are lost.
- Hence, SRAMs are said to be volatile memories because their contents are lost when power is interrupted.
- Static RAMs can be accessed very quickly. Access times on the order of a few nanoseconds are found in commercially available chips.

A single-transistor dynamic memory cell

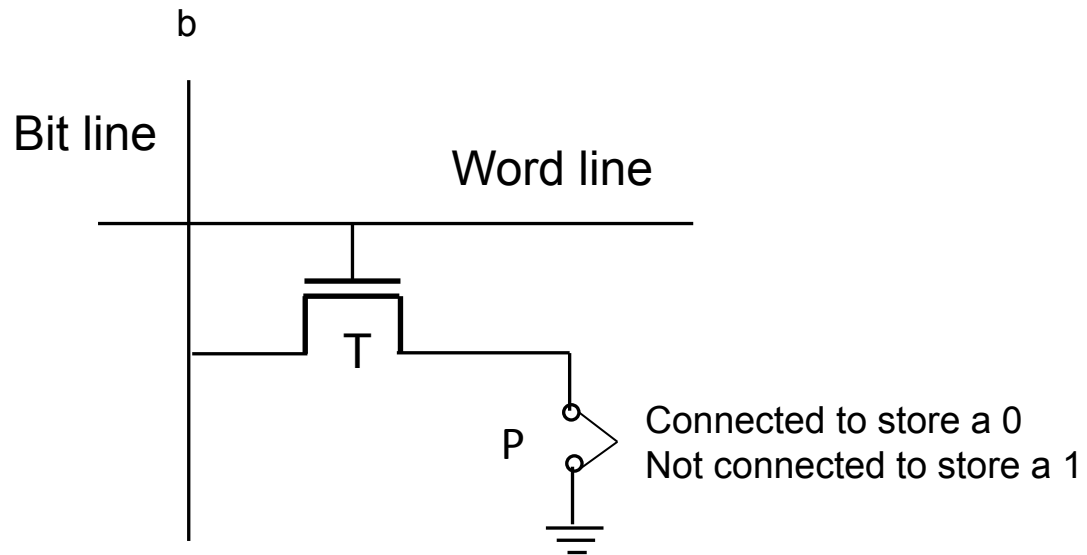


- Static RAMs are fast, but their cells require several transistors.
- Less expensive and higher density RAMs can be implemented with simpler cells.
- But, these simpler cells do not retain their state for a long period, unless they
- Are accessed frequently for Read or Write operations.
- Memories that use such cells are called *dynamic RAMs* (DRAMs).
- Information is stored in a dynamic memory cell in the form of a charge on a capacitor
- charge can be maintained for only tens of milliseconds.
- Since the cell is required to store information for a much longer time,
- its contents must be periodically *refreshed* by restoring the capacitor charge to
- its full value.

Dynamic RAMs

- To store information in this cell, transistor T is turned on and an appropriate voltage is applied to the bit line.
- This causes a known amount of charge to be stored in the capacitor.
- After the transistor is turned off, the charge remains stored in the capacitor, but not for long.
- The capacitor begins to discharge. A sense circuit connected to the bit line detects whether the charge stored in the capacitor is above or below the threshold value.
- If the charge is above the threshold, the sense amplifier drives the bit line to the full voltage representing the logic value 1.
- If the sense amplifier detects that the charge in the capacitor is below the threshold again recharge it.

A ROM cell



- This is called a read-only memory
- Information is written into it only once at the time of manufacture.
- The bit line is connected to the power supply.
- To read the state of the cell, the word line is activated to connect the transistor switch.
- The voltage on the bit line drops to near zero if there is a connection between the transistor and ground.
- If there is no connection to ground, the bit line remains at the high voltage level, indicating logic 1.

PROM

- Some ROM designs allow the data to be loaded by the user, thus providing a programmable ROM (PROM).
- Programmability is achieved by inserting a fuse at point P.
- Before it is programmed, the memory contains all 0s.
- The user can insert 1s at the required locations by burning out the fuses at these

locations using high-current pulses

EPROM

- It allows the stored data to be erased and new data to be written into it.
- This erasable, reprogrammable ROM is called an EPROM. .
- Memory changes and updates can be easily made.
- An EPROM cell has a structure similar to the ROM cell. However, the connection to ground at point P is made through a special transistor.
- The transistor is normally turned off, creating an open switch.
- It can be turned on by injecting charge into it
- It is possible to erase the entire contents of the chip. This can be done by exposing the chip to ultraviolet light.

EEPROM

- An EPROM must be physically removed from the circuit for reprogramming. Also, the stored information cannot be erased selectively.
- Erased, and reprogrammed electrically.
- Such a chip is called an electrically erasable PROM, or EEPROM.
- It does not have to be removed for erasure. Moreover, it is possible to erase the cell contents selectively.

Flash Memory

- Similar to an EEPROM
- The key difference is that, in a flash device, possible to write an entire block of cells.
- Greater density, which leads to higher capacity and a lower cost per bit.
- Use in portable, battery-powered equipment for low power consumption.
- Typical applications include cell phones, digital cameras, and MP3 music players.

Thank You